

Application No.: 10/664,796
Amendment Dated: June 8, 2005
Reply to the Office Action of February 8, 2005

Remarks/Arguments

Claims 1-7, 9-12, and 15-31 are in the application. Claims 1, 19, 20, 26, and 30 are in independent form. Claims 8, 13 and 14 are cancelled by this amendment, and claims 21-31 are added. The originally filed claims were misnumbered, and claim 8 was missing. Rather than renumber the claims, applicants indicate claim 8 as cancelled.

Amendment to the specification

The specification is amended on page 14 to correct a typographical error. The paragraph discusses the magnetic field "B" but uses the symbol "M" for magnetic field in the equation instead of "B."

Rejections under 35 USC § 112

Claims 5 and 16-18 stand rejected under 35 USC § 112 for indefiniteness. Amended claims 5 and 16-18 clarify the antecedent bases.

Rejections under 35 USC § 102(b)

Claims 1, 11, 12, and 16-20 stand rejected under 35 USC 102(b) as anticipated by US Pat. No 5,578,821 to Meisberger et al. ("Meisberger"). Applicants respond as follows.

The invention related to an electron microscope, such as an environmental scanning electron microscope, that operates at a low vacuum. Such microscopes use a gas in the chamber for control of charging, for detection or as part of an experiment. To reduce interference with the primary beam, low vacuum electron microscopes typically use a pressure limiting aperture to reduce the distance that the primary beam travels in the gas. The vapor pressure would also interference with the collection of secondary electrons in a convention detector scheme. The detector scheme in a typical low vacuum scanning electron microscope uses the gas in the sample chamber to amplify the secondary electron signal. The secondary electrons are accelerated to a sufficient energy to ionize the gas and create a cascade of ionizations to amplify the signal. The charged particles eventually impinging on a metal electrode and producing a detectable current. To provide enough collisions for a great amplification, either the gas pressure must be relatively high or the path of the charged particles between the sample and the detector must be relatively long. Placing the detector a long way from the sample, however, would also require the primary beam to travel a longer distance in the gas, which would degrade resolution.

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Similarly, the higher the gas pressure, the more the primary beam degrades as it travels through the gas.

Applicants have invented a configuration in which the electric and magnetic fields cause the charged particles to traverse a relatively long path between the sample and the detector, without requiring a great distance between the sample and the detector. This increases the amplification and provides the flexibility to operate at reduced gas pressures or a shorter sample-to-detector distance.

Meisberger teaches an electron beam inspection system for inspecting integrated circuits and lithography masks. The Abstract describes holding in a vacuum. Meisberger uses solid state electron detectors 117, 160, or 129. As shown by the electron paths in FIG. 5, Meisberger does not use gas amplification. Col. 9, lines 2-10, teach that secondary electrons impact the solid state detector at an energy level sufficient for amplification. Meisberger does not teach an environmental scanning electron microscope in which the secondary electrons are amplified by a cascade of collisions with gas molecules to create additional charged particles which are then detected.

Applicants' invention is an improved system for providing enhanced gas amplification. Gas amplification in an environmental scanning electron microscope is known, but applicant's configuration that can provide significantly enhanced amplification is novel and not obvious. Meisberger does not teach gas amplification at all.

Amended claim 1 specifies a combination of electric and magnetic fields in the detection space to provide "significant magnetron enhanced gas amplification." Claim 19 recites a "gas for amplifying the electrons emanating from the sample" detection space is arranged for comprising a gas for amplifying the electrons emanating from the sample." Claims 20 recites "a gas that is ionized by the secondary particles to amplify the secondary particle signal." Applicants submit that Meisberger uses a solid state detector and does not teach gas amplification.

The Examiner states that Meisberger teaches a gas in the detection space at col. 3, lines 40-43. In those lines Meisberger teaches a "pumping down" step for removing the gas from the vacuum chamber before inspecting the sample. When the sample chamber is opened to insert a sample, the vacuum is destroyed, and so the gas must be removed from the chamber

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before the electron beam system can be used for inspection. The Examiner also cites the Wien filter in col. 10, lines 49-53 to show crossed magnetic and electric fields. The Wien filters 112 and 113 are used to deflect electrons emitted from the sample into the detector 117 without degrading the primary beam 100. The crossed fields are not in a detection space containing a gas for gas amplification.

Regarding claim 12, the Examiner states that Meisberger teaches a plurality of detectors providing an output signal composed of a combination of at least two signals provided by the detection means. Applicants submit that in col. 7, lines 4-17, cited by the Examiner, describes comparing the inspection results of two circuit dice under test, and if the dice appear different, concluding that there is a defect on one of them. Thus, Meisberger compares the results of two samples, not the results of multiple detectors.

Regarding claim 16-18, the Examiner states that Meisberger teaches at col. 13, lines 4-21, that the gas amplification can be 1000 and 5000. Meisberger does not teach gas amplification at all. Meisberger uses solid state detectors. Col. 9, line 3. Regarding claims 19 and 20, the Examiner notes that Meisberger teaches a gas introduction at col. 3, lines 40-43. Col. 3, lines 40-43, teach pumping down the sample chamber to remove gas before inspection.

Rejections under 35 USC § 103(a)

Claims 2-10 and 13-15 stand rejected for obviousness over Meisberger in view of U.S. Pat. No. 6,184,525 to van der Mast. ("van de Mast").

While van der Mast teaches an environmental SEM, it does not teach the claimed configuration and does not achieve the enhanced gas amplification of the claimed configuration. Moreover, van der Mast teaches the addition of complex, multipole magnets or electrodes. See FIGS. 3A and 3B. In applicants' claim 1, for example, the magnetic field is provided by an immersion lens and the electric field is provided by the first detector.

The Examiner states that Meisberger teaches the use of multiple detectors that function in the same way as the claimed detectors. Each of the detectors of Meisberger is an electron detector, and the detectors are used separately and under different conditions. For secondary electrons, the Wien filter 112/113 is set to deflect secondary electrons to detector 117. Col. 8, lines 64-66. For backscattered electrons, "[s]omewhat different setting of the electrostatic and magnetic Wien filter deflectors 112 and 113, cause this beam to be deflected to the left onto the

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solid state detector 160." Col. 9, lines 29-32. Detector 129 below the substrate is used for partially transparent substrates. Col. 9, lines 11-12.

The multiple detectors in claim 12 work concurrently to produce output signals that are combined.

Claim 5 recites "an ion collector arranged to collect ions that are liberated in the gas due to interactions between the gas and said electrons." While van der Mast uses gas amplification and generates ions as well as electrons, van der Mast teaches detecting only the electrons, not the ions.

The Examiner states: "It is obvious that an electric field is produced by the electrode and, and that the electric field and magnetic (sic) can be oriented in the proper manner based on the voltage application to the electrode." While van der Mast teaches specific configurations of electrodes, as shown in FIGS. 3A and 3B, to produce specific fields, applicants have produced unexpectedly great amplification using the claimed configurations which are different from van der Mast. The particle motion achieved by applicants' configuration increases the number of collisions before the charged particles impact the detectors, thereby increasing the amplification. Van der Mast teaches one method of increasing the collisions - - applicants teach a different method that produces significantly greater amplification.

Applicants submit that all claims are now allowable and respectfully requests reconsideration and allowance of the application.

Respectfully submitted,

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